Low-Level Radioactive Waste in Michigan

A Survey of Radioactive Waste Generators

State of Michigan
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Statutory Basis

Section 18(a) of the Low-Level Radioactive Waste Authority Act, 1987 PA 204, as amended (Act 204), requires generators of low-level radioactive waste (LLRW) to annually report to the Michigan Low-Level Radioactive Waste Authority (Authority) certain information on the volume, type, and activity of the LLRW produced. Based on a survey conducted in 2005, this report is a summary of the information submitted by generators for calendar year 2004.

Introduction

Commercial LLRW is a by-product of radioactive materials used in nuclear power plants, industry, and medical and research institutions. It comes in very diverse forms, including laboratory equipment, sealed radiation sources, wiping rags, protective clothing, hand tools, vials, needles, filter resins, and metallic reactor components.

Through the 1970s and 1980s, only three disposal facilities in the nation were licensed to accept commercial LLRW. The states in which these facilities were located (Nevada, South Carolina, and Washington) did not want to continually bear sole responsibility for the nation's LLRW and urged Congress to take action to avoid a disposal capacity crisis. The resulting federal Low-Level Radioactive Waste Policy Act of 1980, and the Policy Amendments Act of 1985, established the requirement that each state, acting alone or in cooperation with other states through an interstate "compact," is responsible for providing disposal capacity for the LLRW produced within its borders.

The Authority was established by Act 204 to fulfill the state's responsibility under federal law to provide for the careful isolation of the LLRW produced by Michigan's hospitals, universities, industry, and nuclear power plants. A siting process was initiated in 1989, but was terminated in 1990.

From November 1990 through mid-1995, Michigan generators of low-level radioactive waste (LLRW) were denied access to the nation's three operating LLRW disposal facilities. This access denial was imposed on Michigan generators because of the setbacks experienced in our efforts to site a disposal facility. In order to determine the problems and challenges that this forced on-site storage might present, in 1992 the Authority conducted an initial survey of waste generators to determine:

- The number of facilities producing and storing LLRW;
- The volume of waste produced annually;
- The volume of LLRW in storage;
- What capacity facilities had to continue to store LLRW;
- The characteristics of the waste in storage, including waste form, principle radionuclides, and activity level; and
- The impacts and costs associated with the need to provide on-site storage.

The 1992 survey was mailed to about 700 facilities that were licensed by the United States Nuclear Regulatory Commission (NRC) or registered by the State Radiological Protection Program, formerly within the Michigan Department of Public Health and currently within the Michigan Department of Environmental Quality (MDEQ). The survey results showed that while the use of radioactive materials is widespread, only a small portion of all licensees or registrants produce waste that must be disposed in an LLRW disposal facility.

In 1994 the Michigan Legislature enacted amendments to Act 204, requiring that generators report annually to the Authority on the volume of waste being produced and in storage and other information on the generation and management of LLRW. The Authority is required to provide a report to the Legislature summarizing the results of the data received from waste generators. The generator survey and this report fulfill the reporting requirements of Act 204.

Surveys conducted between 1994 and 1999 included only those facilities that had indicated in the initial 1992 survey that LLRW was generated at the facility, along with the few facilities that had been licensed after 1992. The 2002 survey was sent to all 983 entities within Michigan that were either licensed with the NRC or registered with the MDEQ's Radiological Protection Program. A total of 36 respondents indicated that they did generate LLRW in 2002 or were still storing LLRW that had been previously generated.

The survey conducted in 2005, seeking data on calendar year 2004 waste management practices and volumes, included only those 36 facilities identified in the last survey as waste generators or waste storers, along with a small number of new facilities that had not been licensed or registered in 2003. This report summarizes the findings for calendar year 2004.

General Findings

For many years, the number of entities actually generating LLRW and the annual volumes of waste have been falling. From 1980 to the late 1990s, the volume of waste requiring burial in a licensed LLRW disposal facility decreased by about 90 percent both within Michigan and nationally. Ever-increasing disposal costs encouraged the development of improved materials management practices and new waste treatment and processing technologies, helping to bring about this volume reduction. The cost of disposal, along with the uncertainty of access to disposal facilities, caused some facilities to cease the use of radioactive materials in order to avoid the generation of LLRW. The first generator survey conducted by the Authority in 1992 identified 49 generators of LLRW in Michigan. The 2005 survey identified only 27 facilities that generated LLRW in calendar year 2004.[1] This reduction occurred in the ranks of hospitals, universities, and research and industrial entities (typically small-quantity waste generators).

The past few surveys have revealed an increase in waste volumes generated. However, this increase was not due to a general increase in waste generation rates, but rather due to two special cleanup projects. The most significant of these is the decommissioning of the Big Rock Point Nuclear Power Plant near Charlevoix. The dismantlement of this plant results in the generation of significant quantities of material that must be treated as LLRW. A special discussion of waste management issues for the Big Rock Point decommissioning project is included at the end of this report.

[1] Some LLRW generators may be missed due to unreturned survey forms.

Survey Results

Michigan Waste Generators

The data presented in Table 1 summarize the responses of the 27 facilities that reported they generated LLRW in 2004, along with five other facilities that were still storing wastes previously generated, but no longer generating waste. Those facilities can be summarized as follows:

Table 1 – **Summary of Responses by Facility Type**

Type of Generator	**Generating LLRW**	**Storing LLRW**
Academic	7	3
Government	2	0
Industry	9	2
Medical	5	0
Utility	4	0
Total	**27**	**5**

Appendix A provides a listing of the facilities included in this Table.

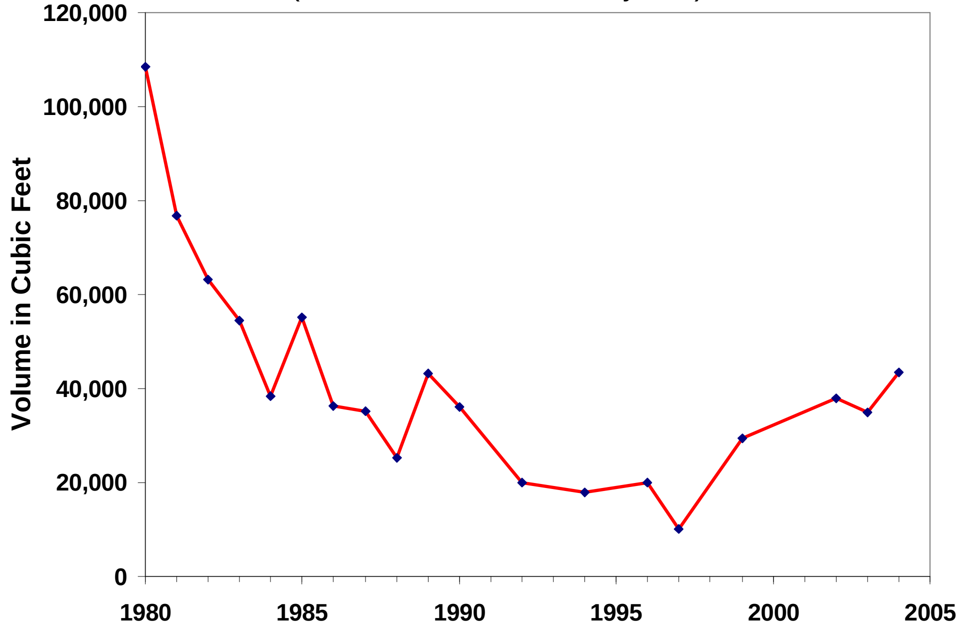
Skyrocketing disposal costs through the late 1980s and 1990s, along with uncertainty about the availability of disposal sites, led to the development and implementation of better waste management practices and to new waste treatment and processing techniques. Through this period, the volume of waste requiring licensed disposal following treatment or processing declined by about 90 percent. The dramatic decline in waste volumes has been experienced in Michigan and nationally.

D.C. Cook steam generators await shipment

Figure 1 shows that Michigan's annual waste generation rate declined steadily through 1997 but shows an increase in waste volumes beginning in 1999. This increase was not due to a general increase in waste generation. Rather, the increase is almost entirely due to two special waste projects. The shipment for disposal of two steam generators from the D.C. Cook Nuclear Power Plant in 1999 comprised nearly 15,000 cubic feet of waste. These steam generators had been removed from the plant itself several years earlier and had been safely stored on-site until their shipment in 1999. They were shipped by train and disposed intact at the Duratek, Inc., facility in Barnwell, South Carolina. The Cook Plant shipped steam generators again in 2004.

The other major contributor to the increase in waste volumes since 1999 has been the decommissioning of the Big Rock Point Nuclear Power Plant. The dismantlement of the plant, near Charlevoix, results in the generation of significant quantities of material that must be treated as LLRW. A specific discussion of the Big Rock Point decommissioning project is presented at the end of this report.

Figure 1
Annual Waste Volumes for Michigan: 1980-2004
(Data not available for all years)



Waste Generation in 2004

Table 2 indicates the volume of waste, by generator category and waste class, that was generated in 2004. The data show that nuclear utilities generate the majority of Michigan's LLRW.

Table 2 – **LLRW Generated in Calendar Year 2004 Requiring Disposal in a Licensed Facility**

Type of Generator	Number of Generators	Cubic Feet Produced in 2004	Percent	Class A* Waste	Class B Waste	Class C Waste	Mixed Waste
Academic	7	1,822	4.2%	1,696	0	0	126
Government	2	17	<0.1%	17	0	0	0
Industry	9	2,084	4.8%	1,345	721	0	18
Medical	5	33	<0.1%	33	0	0	0
Utility	4	39,431†	90.9%	38,971	380	80	0
Total	**27**	**43,387**	**100%**	**42,062**	**1,101**	**80**	**144**

* A description of Waste Classes and Mixed Waste is presented in Appendix B.
† This volume does not include large volumes of rubble from the Big Rock Point decommissioning project.
See discussion at end of this report.

Trends in Generation Rates Over the Next Five Years

The survey asked respondents if they anticipated generating LLRW in future years. It is notable that five respondents anticipated generating waste in future years, even though they did not generate any LLRW in calendar year 2003. Only one respondent who generated waste in 2004 did not anticipate future waste generation.

Table 3 reflects survey respondents' estimates of their annual waste generation rate for each of the next five years. The large increase in utility waste volume expected in 2004 is due to the planned demolition of concrete that housed the Big Rock Point reactor. Much of this rubble will have to be sent to a licensed LLRW disposal facility, in contrast to the volumes of rubble that have been disposed of through 2003 that were largely free of radioactive contaminants.

Table 3 – **Volume of Waste (cubic feet)**

Type of Generator	2004	2005	2006	2007	2008	2009
Academic	1,822	5,028	8,452	2,452	2,042	2,042
Government	17	8	8	8	8	8
Industry	2,084	4,289	4,319	5,339	5,349	6,359
Medical	33	39	41	46	51	56
Utility	39,431	75,930	24,980	16,050	14,350	14,450
Total	**43,387**	**85,294**	**37,800**	**23,895**	**21,800**	**22,915**

Waste Streams

Survey respondents were asked to provide the volume and activity for the different types of wastes that were generated in 2004. Table 4 indicates the volume and activity for a variety of waste types or “streams.” The most significant of these waste streams (in volume or activity) are described in the following paragraphs. A description of all of the waste streams is included in Appendix B.

Table 4 – **Volumes and Activity by Waste Stream**

Waste Stream	Volume (Cubic Feet)	Percent of Volume	Activity (millicuries)	Percent of Total Activity
Dry Active Waste	13,815	31.8%	29,727	0.2%
Medical Generators	0	0.0%	0	0.0%
Aqueous Liquids	706	1.6%	181	<0.1%
Organic Liquids	89	0.2%	8,761	<0.1%
Oils	135	0.3%	450	<0.1%
Animal Carcasses	135	0.3%	147	<0.1%
Biological Waste (Not Animal Carcasses)	0	0.0%	0	0.0%
Ash	0	0.0%	0	0.0%
Activated Equipment	21,703	50.0%	154,000	1.2%
Contaminated Hazardous Material	1	<0.1%	11,552,000	90.9%
Rubble, Sand, and Soil	2,981	6.9%	2,000	<0.1%
Sludge	45	0.1%	11,000	<0.1%
Evaporator Concentrates	800	1.8%	3,200	<0.1%
Air Filter Media, Cartridges	0	0.0%	0	0.0%
Liquid Filter Media, Cartridges	100	0.2%	20,000	0.2%
Ion Exchange Resins	2,852	6.6%	827,300	6.5%
Sealed Sources	25	<0.1%	97,962	0.8%
TENORM	0	0.0%	0	0.0%
Other	0	0.0%	0	0.0%
Total	**43,387**	100%	**12,706,728**	100%

Dry active waste (DAW) consists of protective clothing, glassware, wiping rags, and other materials that may have been in contact with radioactive material and, thus, became contaminated with small amounts of radioactivity. DAW usually is the waste stream generated in the greatest volume. The curie content of DAW is usually very low relative to volume.

Ion exchange resins are filtration materials used in nuclear power plants to remove radioactive contaminants from circulating cooling water. Resins often form the second or third largest waste category in terms of both volume and activity. In this survey, resins account for the majority of total curies, primarily because the volume and curie content of the activated equipment, though appreciable, was lower than in many previous surveys.

Activated equipment or shielding are metal components from within a nuclear reactor or spent fuel pool. By being exposed to the radiation, these materials became radioactive themselves. While this waste category is usually small in volume, it often can contribute a significant percentage of the curie content in the total waste stream. The D.C. Cook steam generators have been included in this waste category, resulting in high volumes in 2004.

Rubble, sand, and soil are waste types characteristic of facility decommissionings, as well as site remediation projects. The waste usually has very low concentrations of radioactive materials associated with it.

Volume in Storage

Generators were asked to identify the volume of waste currently in storage. Most generators will store waste for some period of time prior to disposal. Smaller waste generators may store waste for significant periods of time prior to shipping for disposal in order to have a quantity of waste that is economical to ship. Table 5 indicates, by generator category, the number of facilities reporting waste in storage and the volume of waste in storage.

Table 5 – **Volume of Waste in Storage**

Type of Generator	Facilities Reporting Waste in Storage	Cubic Feet LLRW in Storage	Class A Waste	Class B Waste	Class C Waste	Mixed Waste
Academic	7	1,324	1,294	0	0	30
Government	2	15	15	0	0	0
Industry	6	233	211	10	10	3
Medical	3	29	29	0	0	0
Utility	2	4,649	1,370	100	230	0
Total	**20**	**6,250**	**2,919**	**110**	**240**	**33**

The volumes of waste in storage cited above do not include waste volumes stored for decay. Decay in storage (DIS) is a management practice that can be used for wastes involving radionuclides that have relatively short half-lives (usually less than 90 days). Safely storing such wastes for a period of time equal to ten half-lives of the radionuclides results in a waste material that can be considered nonradioactive. Many clinics and other medical facilities practice decay in storage. However, because these wastes do not require disposal in a licensed LLRW facility, these facilities, and their wastes, are not included in this report.

Volume of Waste Disposed in 2004

There are two licensed LLRW disposal facilities in the United States that accept LLRW from Michigan generators.[2] These facilities are the Duratek, Inc., facility, located in Barnwell, South Carolina, and the Envirocare, Inc., facility, located 80 miles west of Salt Lake City, Utah.

The Duratek, Inc., facility serves as the regional disposal facility for the Atlantic Compact (comprised of Connecticut, New Jersey, and South Carolina). Under the terms of the Atlantic Compact, the Duratek, Inc., facility will accept waste from states other than Atlantic Compact states only until 2008, with an ever-decreasing annual cap on noncompact waste through that year. The Duratek, Inc., facility accepts the full spectrum of LLRW – Class A, B, and C waste. It is the only disposal option for generators of Class B and C wastes in the majority of the states, including Michigan. The Duratek, Inc., facility accepted a total of about 57,000 cubic feet of waste and about 327,000 curies in 2004.[3]

The Envirocare, Inc., facility was established independent of the interstate compact structure but operates with some measure of oversight from the Northwest Compact (Utah is a member state). The Envirocare, Inc., facility can accept waste from generators in all states. The facility can accept all Class A waste, but it is not licensed to accept Class B and C waste. The facility accepts much larger volumes of waste than the Duratek, Inc., facility but a much smaller curie content. (In 2004 the Envirocare, Inc., facility accepted almost 3.7 million cubic feet of waste with a curie content of 3,400 curies.[3])

Table 6 reflects, by generator category, the number of facilities that shipped waste for disposal during 2004, the waste volume as disposed, and the final destination of the waste. Certain waste types were shipped to other facilities besides the two land disposal facilities. For instance, there are several companies that provide for the incineration of aqueous liquids.

The "as disposed" volume figures reflect the volume of waste actually placed in the land disposal facility. Many waste streams can be significantly reduced in volume through treatment and processing prior to burial. Thus, the volumes reflected in this table are smaller than the volumes generated.

Table 6 – **Volume of Waste Disposed in 2004 (in Cubic Feet)**

Type of Generator	**Generators Shipping for Disposal in 2004**	**Volume of Waste Disposed**	**Volume Shipped to Duratek**	**Volume Shipped to Envirocare**	**Other Facilities (or site not identified)**
Academic	4	208	180 (1)*	27 (2)	1 (1)
Government	0	0	0 (0)	0 (0)	0 (0)
Industry	4	576	426 (1)	<1 (1)	150 (2)
Medical	1	19	15 (1)	0 (0)	4 (1)
Utility	4	33,445	1,376 (3)	32,069 (4)	0 (0)
Total	**13**	**34,248**	**1,997 (6)**	**32,096 (7)**	**155 (4)**

* Numbers in parentheses indicate the number of generators that shipped to a particular site.

[2] A third licensed disposal facility, the U.S. Ecology site located near Richland, Washington, accepts waste only from the 11 states that comprise the Northwest Compact and the Rocky Mountain Compact.
[3] Data from the United States Department of Energy's Manifest Information Management System.

Other Waste Management Methods

The survey asked respondents to identify the various waste management methods that were used at their facilities. Table 7 presents the results. It should be noted that many facilities indicate that more than one management method is used.

Table 7 – **Waste Management Methods**

Waste Management Methods	Number of Respondents
Decay to background	22
Return to manufacturer	15
On-site incineration	3
Off-site incineration	13
Controlled release off-site to air, water, or sanitary sewer pursuant to NRC regulations	13
Refrigerated or frozen awaiting licensed disposal facility	4
Noncompacted awaiting licensed disposal facility	17
Compacted awaiting licensed disposal facility	11
Solidified awaiting licensed disposal facility	6
Dewatered awaiting licensed disposal facility	3
Curtailment of LLRW generation (elimination or substitution of activities previously generating LLRW)	14
Off-site treatment with return for storage	0
Brokerage storage for decay	2
"Green is Clean"	5
Other	5

Decay to Background: Hospitals, universities, and research institutions often use radionuclides with relatively short half-lives. The NRC permits wastes containing radionuclides with half-lives of up to 90 days or less to be stored until the radioactivity has decayed to background--a period recognized as being equal to ten half-lives for any particular radionuclide. Almost all universities and medical facilities indicated that some wastes were stored for decay.

Return to Manufacturer: A “sealed source” is a radioactive material sealed in a container to prevent contact with, or dispersion of, the radioactive material. Sealed sources are used in a variety of different ways in medical treatment and in industrial and manufacturing processes. Examples include devices used to examine welded joints, to test the thickness of paper, and to control fluid levels in bottling plants. Sealed sources are often returned to the manufacturer after the radionuclide source has decayed.

On-site Incineration: Facilities may be licensed to incinerate certain waste material under strict limits imposed by the NRC. Three licensees incinerate some of their LLRW on-site. The resulting ash is treated as LLRW.

Off-site Incineration: There are several commercial LLRW incinerators operating elsewhere in the country. The resulting ash is treated as LLRW. Ash may be solidified to avoid dispersal problems. Scintillation fluids (chemical solutions often used in biomedical research) are often incinerated, leaving no residual waste.

Controlled Release to Air, Water, or Sanitary Sewer: NRC regulations allow for the discharge of small concentrations of radionuclides to the air, water, or sanitary sewage systems. The concentration limits established by the NRC for such releases are very conservative. For instance, the concentrations for sewer release are set so that a person would get no more than 500 millirem of exposure in a year if the sewer discharge was the person's only source of drinking water.

Refrigerated or Frozen: Biological wastes, particularly animal carcasses used in laboratory experiments, are often frozen to forestall biological deterioration if disposal is not possible or delayed. Hospitals, universities, and research institutions may use this technique.

Noncompacted Awaiting Licensed Disposal: Many waste generators, particularly the small quantity generators, simply containerize their wastes in drums until disposal is available. The waste materials are dry solids.

Compacted Awaiting Licensed Disposal: Some waste generators use compactors to reduce the volume of dry solid wastes. Generators may have their own compactor or send waste to a commercial compactor for treatment and return.

Solidified Awaiting Licensed Disposal: Some liquid or wet wastes can be solidified by the use of concrete, asphalt, or epoxies. The resulting waste form is more stable; however, often the volume is increased substantially through the addition of the solidifying agent. Liquid wastes are not permitted in licensed LLRW disposal facilities.

Dewatered Awaiting Licensed Disposal: Ion exchange resins used in nuclear power plants to remove radioactive contaminants from circulating cooling waste are often "dewatered" or dried prior to being placed into storage or sent for disposal.

Curtailment of LLRW Generation: Over the past decade, the volume of LLRW being generated has declined significantly, due to better waste management practices, new waste treatment technologies, and eliminating or substituting activities or procedures that would generate LLRW. Due to the uncertainty of disposal and the cost of both storage and disposal, most waste generators continue to search for ways to reduce the amounts of LLRW being produced.

Off-site Treatment with Return for Storage: During the years when disposal was not possible, Michigan generators were still able to send wastes out of state to commercial waste treatment or processing facilities. The waste was returned to the individual generator following compaction or incineration to await final disposal. Now that wastes can be disposed, no generators are having wastes treated and returned.

Brokerage Storage for Decay: Some wastes with radionuclides of short half-lives can be stored until decayed. If a generator has no space to store waste for decay, waste can be sent to a brokerage for storage. After the radionuclides have sufficiently decayed, the material can be disposed as nonradioactive waste.

Brokerage Services

Survey respondents were asked whether or not a brokerage service was used to manage their LLRW. A brokerage service usually picks up waste from a variety of waste generators and then properly packages, manifests, and ships the waste for disposal. The brokerage service may also provide some waste treatment or processing or send it to a third party for processing prior to disposal.

Most LLRW generators made use of brokerage services. Of 27 waste generators, 19 indicated that a brokerage service was used for some portion of their overall waste management scheme.

Off-Site Waste Treatment and Processing

Generators were also asked to identify any commercial waste treatment or processing companies (separate from brokerage services) that were used to treat wastes prior to disposal. Nuclear power plants utilize waste treatment and processing more than other generators. The four nuclear power plants each indicated that a variety of commercial waste treatment and processing services were used to volume-reduce and stabilize their LLRW. Among the 23 nonutility generators, only 10 utilized commercial treatment or waste processing separate from brokerage services.

Table 8 indicates the number of facilities, by type of generator, that indicated employment of a waste brokerage and/or off-site waste processor to help manage LLRW.

Table 8 – **Use of Waste Management Services**

Type of Generator	Number of Generators Utilizing Brokerage Services	Number of Generators Utilizing Off-Site Waste Treatment
Academic	7	2
Government	2	1
Industry	6	4
Medical	2	3
Utility	2	4
Total	**19**	**14**

Big Rock Point Decommissioning Project

The Big Rock Point Nuclear Power Plant, operated by Consumers Energy near Charlevoix, permanently stopped generating electricity in August 1997 and began the process of decommissioning the plant shortly after shutdown. The goal of decommissioning is to completely dismantle the plant, remove all waste material and any contaminants, and return the site to unrestricted use.

The process of decommissioning creates large volumes of waste material. Much of the material is ordinary, uncontaminated building demolition material. Some hazardous waste is produced, such as asbestos and contaminated oils. Large volumes of LLRW must also be removed from the site and properly treated and disposed.

As an NRC licensee, Consumers Energy is required to consider virtually all decommissioning waste leaving Big Rock Point as LLRW, unless it can be shown that the material does not include any radioactivity above background levels. The volumes reflected in this report do not include a significant volume of concrete rubble that was generated in the decommissioning process, but that was deemed to be "nonimpacted" by radioactive contaminants and was disposed as ordinary demolition debris.

Most of this nonimpacted rubble was shipped to a Michigan Type II landfill as normal demolition debris, following on-site procedures to comprehensively assess the material and ensure that the rubble was free of radioactive contaminants. Consumers Energy had applied for, and received, approval from the NRC to dispose of this nonimpacted debris under Title 10 of the Code of Federal Regulations, Section 20.2002, Method for obtaining approval of proposed disposal procedures, allowing for an alternate disposal method. Under this provision, Consumers Energy was required to demonstrate that this disposal method would not adversely affect public health or the environment.

A smaller volume of nonimpacted rubble was disposed as ordinary demolition debris following shipment to a radioactive waste treatment facility and determined at that facility to be free of contamination. This waste evaluation process by the waste treatment facility is known as "Green is Clean."

The decommissioning is expected to be completed by the fall of 2006.

The Future of LLRW Disposal

As noted earlier, there are only two facilities that accept Michigan LLRW for disposal. The Duratek, Inc., facility in South Carolina is the only facility that accepts Class B and C wastes from the majority of states, including Michigan. Under South Carolina law, the Duratek, Inc. facility will no longer accept LLRW from states other than the states of its three-state compact after June 2008.

The loss of access to the Duratek, Inc., facility may pose problems for generators across the country in the disposal of Class B and C wastes. Generators in Michigan and 35 other states may have to store such wastes or take steps to avoid generating them.

Survey respondents were asked if the loss of access to the Duratek facility would impact their operations and what steps, if any, were being taken to address those possible impacts. Because most respondents do not generate Class B or C wastes, they indicated that there would be no impact. The nuclear power plants indicated that storage of Class B and C wastes would be necessary, and most indicated they were prepared to do so. The most significant impact might be felt by any facilities that will be decommissioning following this loss of access.

Class B and C wastes form only a small percentage of the overall LLRW waste stream. The generation of some Class B and C wastes, such as activated reactor hardware, cannot be avoided. Other wastes that sometimes fall within Class B or C limits can be avoided. For instance, a batch of filter resins used in nuclear power plants can become Class B or C waste if used over a significant time period. If replaced earlier, the material can meet Class A limits. While avoiding the creation of Class B or C wastes, such a strategy results in the creation of greater overall volumes of LLRW.

A recent report by the United States General Accounting Office recently reached the following conclusion regarding the management of Class B and C wastes: "If disposal conditions do not change…most states will not have a place to dispose of their Class B and C wastes after 2008. Nevertheless, any disposal shortfall that may arise is unlikely to pose an immediate problem because generators can minimize, process, and safely store wastes."[4] The report does acknowledge that long-term storage of ever-increasing volumes of such wastes may result in increased safety and security risks.

No shortfall is foreseen in the availability of adequate disposal capacity for Class A wastes.

[4] "Low-Level Radioactive Waste: Disposal Availability Adequate in the Short-term, but Oversight Needed to Identify Any Future Shortfalls," United States General Accounting Office; June 2004

Appendices

Appendix A

2004 Low-Level Radioactive Waste Generator Survey Respondents

Colleges/Universities	County	Generating LLRW	Storing Only	Future Generating
Calvin College	Kent	x		x
Central Michigan University	Isabella		x	
Eastern Michigan University	Washtenaw	x		x
Michigan State University	Ingham		x	x
Michigan Technological University	Houghton	x		x
Northern Michigan University	Marquette		x	x
Oakland University	Oakland	x		x
University of Michigan	Washtenaw	x		x
Wayne State University	Wayne	x		x
Western Michigan University	Kalamazoo	x		x
Government				
U.S. Army TACOM	Macomb	x		x
U.S. Dept. of Commerce (GLERL)	Washtenaw	x		x
Industry				
Aastrom Biosciences	Washtenaw	x		x
Cayman Chemical	Washtenaw	x		x
Dana-Perfect Circle Division	Muskegon	x		x
The Dow Chemical Company	Midland	x		x
Esperion Therapeutics, Inc.	Washtenaw	x		x
General Motors R & D Center	Macomb	x		x
Kinnco, Inc.	Grand Traverse		x	
Michigan Biotechnology Inst.	Ingham		x	x
Pfizer Global R & D	Washtenaw	x		x
Pharmacia & Upjohn Company	Kalamazoo	x		x
TSRL, Inc.	Washtenaw	x		x
Hospitals/Medical Centers				
Childrens' Hospital of Michigan	Wayne			x
Cardinal Health	Ottawa	x		x
Cardinal Health	Wayne	x		x
Henry Ford Health Systems	Wayne	x		x
VHA Ann Arbor	Washtenaw	x		x
William Beaumont Hospital	Oakland	x		x
Nuclear Power Plants				
Consumers Energy - Big Rock Point	Charlevoix	x		x
Consumers Energy - Palisades	Van Buren	x		x
Detroit Edison Co. - Fermi II	Monroe	x		x
Indiana-Michigan Power Co. - D.C. Cook	Berrien	x		x

Appendix B

Description of Waste Classes and Waste Streams

Waste Class

Class A: LLRW that has the largest volume but lowest concentrations of long-lived and/or short-lived radionuclides. Most Class A waste decays to a level that no longer poses a hazard within 100 years. Class A waste includes most LLRW from hospitals and universities and the majority of waste from nuclear power plants.

Class B: LLRW that has small volumes but intermediate concentrations of long-lived and/or short-lived radionuclides. Class B wastes must meet more rigorous waste form requirements than Class A to ensure stability. Most Class B waste decays to a level that no longer poses a hazard within 100 to 300 years. Class B waste can include certain radiopharmaceutical wastes, sealed sources, and some ion exchange resins from nuclear power plants.

Class C: LLRW that has the smallest volumes but the highest concentrations of long-lived and/or short-lived radionuclides. Class C wastes must meet more rigorous waste form requirements to ensure stability and must be disposed of at a depth of at least five meters below the surface or be disposed of with intruder barriers. Most Class C waste decays to a level that no longer poses a hazard within 500 years. Class C waste is limited almost exclusively to some ion exchange resins, some sealed sources, and activated metal components from nuclear power plants.

It is important to note that all of the waste classes can contain radionuclides with long half-lives. It is the concentration of the radionuclides within a waste material, more than the half-life of the radionuclides present, that often determines the class of waste.

Mixed Waste: Waste material that contains radioactive constituents, as defined under Title 10 of the Code of Federal Regulations, Part 61, Licensing Requirements for Land Disposal of Radioactive Waste, and hazardous constituents, as defined under federal hazardous waste rules in Title 40 of the Code of Federal Regulations, Part 261, Identification and Listing of Hazardous Waste. Both the radiological and chemical hazard of the mixed waste must be considered in the management and disposal of this waste.

Waste Streams

Activated Equipment (or Shielding): Tools, instruments, equipment, and lead shielding made radioactive by irradiation from a nuclear reactor or spent fuel pool.

Air Filter Media, Cartridges: Air filters or the media used within air filters, such as charcoal or cellulose fibers.

Animal Carcasses: Radioactivity contaminated animal carcasses or body parts usually resulting from animal research. Animal carcasses present a special storage problem in that they often require freezing to inhibit biological degradation.

Aqueous Liquids: Wastes that are dissolved in water. Liquid waste must be solidified before shipment to a disposal facility. Liquids cannot be accepted for disposal.

Ash: Incinerating LLRW results in substantial volume reduction but most of the radioactivity is still present in the ash. Ash is often solidified with cement, asphalt, or other material prior to disposal or storage.

Biological Waste: Other biological waste may include animal bedding and excreta and laboratory culture media.

Contaminated Hazardous Material: Wastes that have hazardous constituents or properties as designated by United States Environmental Protection Agency or MDEQ regulations, as well as contamination with radionuclides. This type of waste is also referred to as "mixed waste."

Dry Active Waste (DAW): Solid waste that commonly consists of protective clothing, glassware, paper, cloth, and plastics that may have been contaminated with radioactive material. Some DAW can be compacted or incinerated.

Evaporator Concentrates: Evaporation of contaminated water is a common treatment method at nuclear power plants. The concentrated residue produced during the process is solidified before disposal.

Ion Exchange Resins: Organic polymer materials used to remove radioactive contaminants from circulating cooling water and used for other water treatment systems within nuclear power plants.

Liquid Filter Media, Cartridges: Filters or filter media used to remove radionuclides from water.

Medical Generators: A commercially available device used to create a short-lived radionuclide (to be used in a medical application) from a parent radionuclide. The most widely used medical generator is used to produce technetium-99m from a molybdenum source. The device is usually returned to the manufacturer at the end of its useful life.

Oils: Lubricating or machine oil that has become contaminated with radioactive materials.

Organic Liquids: Chemical compounds such as alcohols or solvents such as benzene, xylene, and toluene that have been contaminated with radioactive materials.

Rubble, Sand, and Soil: Concrete, gravel, soil, or other building rubble contaminated with radioactive materials. These wastes are usually generated in the process of decommissioning a licensed facility.

Sealed Sources: A radioactive source sealed in a container to prevent contact with, or dispersion of, the radioactive material during its use. Sealed sources are used in a wide variety of medical, research, industrial, and construction applications.

Sludge: Produced when filtering contaminants, sludges include powdered ion-exchange resins, diatomaceous earth, suspended solids, silica, and metal oxides.

TENORM: Technologically-Enhanced Naturally Occurring Radioactive Material results from naturally occurring radionuclides being concentrated by some man-made process. For example, radium scale can develop on oil and gas well piping.

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

LOW-LEVEL RADIOACTIVE WASTE AUTHORITY

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT SURVEY

For Calendar Year 2004

Under Section 18(a) of Act 434 (P.A. of 1994), generators of low-level radioactive waste (LLRW) are required to provide information to the Michigan Low-Level Radioactive Waste Authority on an annual basis, or as required by the Authority. Information requested includes waste volumes, curie content of the waste, and other data relevant to waste management and disposal. This survey will fulfill the generator's reporting requirements for calendar year 2004.

This survey is due June 10, 2005

Please complete and return this survey to the Low-Level Radioactive Waste at the following address:

Low-Level Radioactive Waste Authority
Michigan Department of Environmental Quality
P.O. Box 30241
Lansing, MI 48909-7741

If you have any questions concerning this survey, contact Thor Strong, Acting Commissioner of the Michigan Low-Level Radioactive Waste Authority, at 517-241-1252. (strongt@michigan.gov)

Facility Name and Address: ____________________

____

____

____

Contact Person: ____________________

Title: ____________________

Telephone Number: ____________________

If other facility locations are included in this response, please attach a list identifying them.

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT SURVEY

1. If your facility has a U.S. Nuclear Regulatory Commission (NRC) License Number, please enter that here. If all radioactive materials are possessed under an NRC General License, indicate "GL":
   ____

2. Do you generate LLRW which, due to short half life of isotopes, may be stored for decay and eventually disposed as non-radioactive waste?
   YES____ NO____

For all remaining questions, DO NOT include: 1) waste that is stored for decay which can then be disposed as non-radioactive waste; 2) sealed sources which can be returned to the manufacturer

3. A. In 2004, did your facility generate radioactive waste which requires disposal in a licensed LLRW disposal facility?
   YES____ NO____

   B. Do you anticipate generating LLRW in the future?
   YES____ NO____

   C. Is your facility storing any radioactive material or waste, generated prior to 2004, which is now awaiting disposal?
   YES____ NO____

*If you answered "**NO**" to 3A, 3B* **AND** *3C, it is not necessary to complete the rest of the survey. Please sign the last page and return the survey to the Low-Level Radioactive Waste Authority.*

*If you answered "**YES**" to 3A ,3B,* **OR** *3C, please complete all remaining questions that are appropriate and applicable.*

WASTE MANAGEMENT

4. A. Please estimate the volume of LLRW generated in calendar year 2004 that has been disposed, or will require disposal, in a licensed disposal facility.

   Total Cubic Feet __________

   B. If known, break down the total volume entered in 4A into waste classes. Appendix 1 provides a description of waste classes.

   Class A ____ Class B ____ Class C ____ Mixed ___ Don't Know ____

5. Please estimate the volume (in cubic feet) of LLRW that your facility will generate in each of the next five years. If you are unsure of Waste Class, enter as Class A.

	2005	2006	2007	2008	2009
Class A					
Class B					
Class C					
Mixed					

6. Use the following table to characterize the LLRW generated in calendar year 2004. Please indicate the volume, total activity and principle radionuclides for each waste stream that will require disposal in a licensed LLRW facility. The estimated volume for all waste streams reported should equal the total cubic feet volume reported in 4A.

A. Dry Active Waste
B. Medical Generators
C. Aqueous Liquids
D. Organic Liquids (not oils)
E. Oils
F. Animal Carcasses
G. Biological Waste (exclude animal carcasses)
H. Ash
I. Activated Equipment or Shielding (radioactive by irradiation)
J. Contaminated Hazardous Material
K. Rubble, sand, soil etc.
L. Sludge
M. Evaporator Concentrates
N. Air Filter Media, Cartridges
O. Liquid Filter Media, Cartridges
P. Ion Exchange Resins
Q. Sealed Sources
R. TENORM
S. Other (describe)________________
____

Waste Stream	Estimated Volume (Cubic Feet)	Total Activity (Indicate units: *μCi, mCi, Ci)*	Principle Radionuclides

7. Check each waste management method currently used, either by you at your facility, or by an off-site waste processor, to manage your LLRW.

A. __Decay to background
B. __Return to manufacturer or supplier
C. __On-site incineration
D. __Off-site incineration
E. __Controlled release pursuant to 10CFR20
F. __Refrigerated or frozen, prior to disposal
G. __Noncompacted prior to licensed disposal
H. __Compacted prior to licensed disposal
I. __ Solidified prior to licensed disposal
J. __ Dewatered prior to licensed disposal
K.__ Curtailment of LLRW generation (elimination or substitution of activities previously generating LLRW)
L.__ Off-site treatment with return for storage
M.__ Brokerage storage for decay
N.__ “Green is clean”
O.__ Other (Please describe) _______________
____
____
____

8. If your facility uses a waste brokerage service (a company which packages and collects waste) so that you do not have to deal with a disposal site directly, please provide the name of the company(s) and the state(s) where the broker(s) is located.

____

____

9. If your facility shipped waste off-site for treatment or processing prior to disposal (incineration, compaction, etc.), identify the waste processor(s) and the state(s) where the processor(s) are located.

____

____

WASTE DISPOSAL

10. Please estimate the volume of waste shipped for disposal (either directly or through a broker or processor) at a licensed LLRW disposal facility in calendar year 2004.

Total Cubic Feet ________

11. Please identify the volume (in cubic feet) of waste sent to the following disposal sites during calendar year 2004:

Duratek, Inc. (Barnwell, South Carolina) _______
Envirocare of Utah, Inc. (Clive, Utah) _______
U.S. Ecology (Richland, Washington)
Other (please identify) ____
Don't know _______

WASTE IN STORAGE

12. A. Please estimate the cubic feet of LLRW, currently in storage, that will require disposal in a licensed LLRW disposal facility.

Total Cubic Feet ________

B. If known, break down the total volume entered in 12A by waste class:

Class A _____	Class B _____	Class C _____	Mixed _____	Don't Know ____

C. What percentage of the waste in storage was generated in calendar year 2004? _____%

13. What difficulties, if any, are you experiencing in your effort to ship stored wastes for disposal? Please explain:

14. The Duratek, Inc. disposal facility in Barnwell, S.C. will cease accepting waste from Michigan generators in July, 2008. This facility is currently the only option for disposal of Michigan's Class B and C wastes. Please explain any impact this loss of access will have on your facility and any steps being taken to address the issue.

15. Please provide any other comments or explanations that will assist us understand your responses to this survey. ____________________

Signature: ____________________ Date: ____________________

Facility: ____________________

Classification of Radioactive Waste
(10 CFR 61.55)

Determination of the classification of radioactive waste (Class A, B, or C) involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

I. Classification determined by long-lived radionuclides. If the radioactive waste contains only radionuclides listed in Table 1, classification shall be determined as follows:
  1. If the concentration does not exceed 0.1 times the value in Table 1, the waste is Class A.
  2. If the concentration exceeds 0.1 times the value in Table 1, but does not exceed the value in Table 1, the waste is Class C.
  3. If the concentration exceeds the value in Table 1, the waste is generally not acceptable for land disposal.
  4. For wastes containing mixtures of radionuclides listed in Table 1, the total concentration shall be determined by the sum of fractions rule described in subsection (g).

Table 1

Radionuclide	Concentration Curies/cu. m.
C-14	8.00
C-14 in activated metal	80.00
Ni-59 in activated metal	220.00
Nb-94 in activated metal	0.20
TC-99	3.00
I-129	0.08
Alpha emitting transuranics w/ half-life>5 years	100.00*
Pu-241	3,500.00*
Cm-242	20,000*

*Note: Units are in nanocuries per gram

Radionuclide	Concentration Curies/cubic meter		
	Column 1	Column 2	Column 3
Total of all radionuclides w/ <5 year half-life	700.00	*	*
H-3	40.00	*	*
Co-60	700.00	*	*
Ni-63	3.50	70.00	700.00
Ni-63 in activated metal	35.00	700.00	7000.00
Sr-90	0.04	150.00	7000.00
Cs-137	1.00	44.00	4600.00

Table 2

*Note: There are no limits established for these radionuclides in Class B or C wastes. These wastes will be Class B unless the concentration of other radionuclides in Table 2 determine the waste to be Class C independent of these radionuclides.

II. Classification determined by short-lived radionuclides. If the waste does not contain any of the radionuclides listed in Table 1, classification shall be determined based on the concentrations shown in Table 2. If radioactive waste does not contain any radionuclides listed in either Table 1 or 2, the waste is Class A.
  1. If the concentration does not exceed the value in Column 1, the waste is Class A.
  2. If the concentration exceeds the value in Column 1, but does not exceed the value in Column 2, the waste is Class B.
  3. If the concentration exceeds the value in Column 2, but does not exceed the value in Column 3, the waste is Class C.
  4. If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.
  5. For wastes containing a mix of radionuclides listed in Table 2, the total concentration shall be determined by the sum of fractions rule.

III. Classification determined by both long- and short-lived radionuclides. If the radioactive waste contains radionuclides which are listed in both Tables 1 and 2, classification shall be determined as follows:
  1. If the concentration of a radionuclide listed in Table 1 is less than 0.1 times the value listed in Table 1, the class shall be determined by the concentration of radionuclides listed in Table 2.
  2. If the concentration of a radionuclide listed in Table 1 exceeds 0.1 times the value listed in Table 1, but does not exceed the value in Table 1, the waste shall be Class C, provided the concentration of radionuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2